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Method and Device for Applying a Reinforcement to a Plastic Pipe by way of a Wrap Welding Process

The present invention concerns a method and a device for producing a reinforcement on a plastic pipe and a plastic pipe comprising a reinforcement.

Methods and devices for producing reinforced sleeves on plastic pipes are known in the prior art. For example, it is known from DE 101 52 604 A1 to slide a plastic pipe by one end onto a mandrel and to rotate it with the mandrel about its longitudinal axis, while during this rotation a layer of plastic is extruded onto a preformed sleeve region of the pipe to constitute a reinforcing sleeve that is formed onto the plastic pipe. This method does, in fact, reinforce the plastic pipe against one-time static loads. However, it provides very little reinforcement against permanent static loads, which would also prevent the plastic from creeping. Such permanent loading occurs primarily in the sealing area of the sleeve when another plastic pipe is inserted in the sleeve and an annular seal presses with great pressure against the sleeve from the inside. Over time, this pressure can cause the plastic pipe to creep, causing leaks in the sleeve area.

It is, therefore, an object of the present invention to provide a plastic pipe comprising a reinforcement at a connection site or sleeve in which there is an improved loading capacity with respect to permanent loads, in order to prevent the plastic from creeping. It is also an object of the invention to provide a method and a device for producing such a plastic pipe.

This object is achieved by means of a method according to Claim 1, a device according to Claim 22 and a plastic pipe according to Claim 14. The dependent claims relate to advantageous configurations of the invention.

The exemplary embodiments of the invention are described in more detail below with reference to the following drawings.

Fig. 1 shows a plastic pipe with a reinforced sleeve according to the present invention;

Fig. 2 shows a first exemplary embodiment of a device according to the present invention for producing a reinforcement on a plastic pipe;

Fig. 3 shows a second exemplary embodiment of a device according to the present invention for producing a reinforcement on a plastic pipe;

Fig. 4 shows a third exemplary embodiment of a device according to the present invention for producing a reinforcement on a plastic pipe;

Fig. 5 shows a fourth exemplary embodiment of a device according to the present invention for producing a reinforcement on a plastic pipe;

Fig. 6 shows an enlarged detail of the first and second exemplary embodiments;

Fig. 7 shows an enlarged detail of the third and fourth exemplary embodiments;

Fig. 8 shows an arrangement that can be used for an inventive device alternatively to the arrangements illustrated in Figs. 6 and 7;

Fig. 9 shows another arrangement that can also be used for an inventive device alternatively to the arrangements illustrated in Figs. 6 and 7;

Fig. 10 shows an arrangement for supporting and rotating a plastic pipe for the first and third exemplary embodiments;

Figs. 11 and 12 illustrate still another arrangement that can be used for an inventive device alternatively to the arrangements illustrated in Figs. 6 and 7;

Fig. 13 shows a reinforced sleeve according to the present invention;

Fig. 14 shows a device according to the present invention disposed downstream of a corrugated pipe plant equipped with an extruder.

Figure 1 represents a plastic pipe 1 with a corrugated outer wall and a smooth inner wall. Plastic pipe 1 has a sleeve or connection site 3 [sic] for connection to another plastic pipe 3, which connection site 2 is sealed with a gasket 4. In the area of gasket 4, connection site 2 of plastic pipe 1 comprises a reinforcing

band 5, which according to the present invention provides reinforcement not only against one-time static loads but also against permanent static loads, to prevent the connection site 2 from creeping in the region of the gasket 4.

The reinforcing band 5 is made of plastic, particularly of thermoplastic plastic, e.g. the material of the plastic pipe, high-density polyethylene (HDPE) or polypropylene (PP), and contains one or more reinforcing materials that have a high and permanent tensile strength, particularly natural fibers, synthetic fibers, synthetic yarns, glass fibers, fiberglass fibers, Kevlar fibers, carbon fibers, metal fibers or metal wires. It is particularly advantageous in this regard to use simple or braided yarns made of these reinforcing materials or woven fabrics made of these reinforcing materials. Most notably, flat woven metal fabrics have proven to be especially suitable reinforcing materials for the present invention. Not only do woven metal fabrics have a high permanent tensile strength, but they also exert relatively little surface pressure against the plastic pipe, thereby preventing any incising if the reinforcing material is applied to the plastic pipe with a prestress.

The reinforcing materials are advantageously oriented in the longitudinal direction of the reinforcing band and can be applied one-sidedly to the plastic of the band. It is advantageous, however, if the reinforcing materials are coated with plastic on both sides or are embedded in plastic. The proposed reinforcing materials bring about a resistance to permanent static loads that has not been achieved heretofore, such that the plastic of pipes can be prevented from creeping in the sealing areas of sleeves. The use of braided steel ropes and woven metal fabrics is particularly advantageous in this regard. This makes it possible to ensure a permanent seal with plastic pipes that are more than 2 m in diameter.

The reinforcing band 5 can be wound once around the connection site 2, in which case the beginning and the end of the reinforcing band 5 are joined. It is advantageous, however, to wrap the reinforcing band over itself more than once – as indicated in Fig. 13 – to achieve a self-locking effect. The reinforcing band 5 can in this case be wrapped about the connection site 2 in spiral and/or overlapping fashion, the end area of the wound reinforcing band being welded or glued directly to the connection site or to the immediately underlying winding of the reinforcing band 5. The reinforcing band 5 is advantageously heat-welded to the connection site 2. It is also sufficient, however, if the reinforcing band 5 is merely glued to the connection site 2.

The reinforcing band 5 can be applied to the connection site 2 by means of a wrap welding process described hereinafter. However, according to the present invention it is also possible for the reinforcing band 5 to be extruded directly onto the connection site 2 along with the reinforcing material.

Figure 2 shows a first exemplary embodiment of a device 6 according to the present invention for producing a reinforcing band on a plastic pipe 1. Illustrated in the left-hand portion of Fig. 2 is a feed device 7, by which a plastic pipe [is] to be transferred with the aid of lever arms 8 into the working position 9 of the inventive device 6, depicted in the center of Fig. 2. Alternatively to the lever arms 8 shown in Fig. 2, a lifting cross-conveyor can also be used. The plastic pipe 1 is held in working position 9 by support rollers 10, 11 and by upper pressure rollers 12, support roller 11 being driven by a motor 13 so that it is able to rotate plastic pipe 1. Device 6 further comprises an arrangement for conveying a reinforcing band 5 and an arrangement for welding the reinforcing band 5 to the plastic pipe 1, which in Fig. 2 are denoted jointly by reference numeral 14.

In Fig. 2, arrangements 14 are disposed fixedly in device 6, the winding-on of reinforcing band 5 being effected by rotating plastic pipe 1 one or more times. However, it is also possible, as illustrated in Fig. 3, for arrangements 14 to be guided around the plastic pipe 1 one or more times while plastic pipe 1 remains fixedly clamped in a clamping device 16. This rotational movement of arrangements 14 can be achieved by rotating them by means of a live ring or rotor 15, driven by a motor 17. In Fig. 3, rotor 15 is connected to motor 17 via a V-belt or drive belt 18. It is also possible, however, for motor 17 to be installed directly on the device 6, in which case a pinion mounted on the motor directly engages teeth on the outer circumference of the rotor 15.

Arrangements 14 must be able to rotate at least about 360° in this embodiment. It is advantageous, however, if multiple rotations about plastic pipe 1 are possible. Arrangements 14 can be driven reversibly to permit easier powering via connector cables, which when permanently connected cannot be wound around the plastic pipe an arbitrary number of times.

The particular advantage of rotationally moving arrangements 14 around plastic pipe 1 is that in this way, inventive device 6 can be disposed immediately downstream of a corrugated pipe plant or corrugator 19, as illustrated in Fig. 14. The corrugator 19 is fed with plasticized plastic by an extruder 20 equipped with an injection head 21, to produce a plastic pipe 1. It is not possible to rotate the plastic pipe 1 in this

production process. Hence, the inventive device 6 provided with rotating arrangements 14 makes it possible for the first time to apply a reinforcing band 5 immediately after the forming section of a corrugator 19, thus enabling pip production on the whole to take place more efficiently and with less space consumption.

Since plastic pipe 1 moves slowly along the forming section as it is being fabricated (cf. arrow 22 in Fig. 14), it is advantageous if device 6 can be moved by means of a motor 23 along rails 25 synchronously with the production speed of the plastic pipe 1. For precise manipulation, it is advantageous in this case to provide a clamping device 26. During the inventive wrap welding process, device 6 thus moves from the upstream end of the rails 25 to the downstream end of the rails 25. Device 6 is then moved by means of motor 23 back to its upstream end to provide the next connection site 2 with a reinforcing band 5. It should be noted here that the plastic pipes are produced in a continuous process with the connection sites built in, and after the plastic pipe has been fabricated it is severed in the desired length, or cut to length, to yield individual pieces of pipe.

Various ways of implementing arrangements 14 for producing or applying the reinforcing band 5 are depicted in Figs. 6 to 9 and in Figs. 11 and 12. Illustrated in Fig. 7 is a drum 30 on which the reinforcing band 5 is wound. Reinforcing band 5 is fed over a guide roller 31 and a pressing roller 32 of a drive device 33, which unwinds reinforcing band 5 from drum 30 to feed it to a work area 34 on plastic pipe 1. The drive unit 33 comprises a driven roller 35 and a counter-roller 36, which is pressed against the driven roller 35 by a pneumatic or hydraulic cylinder 37. The work area 34 is heated by means of a hot air blower 38 equipped with a hot air nozzle 39 to locally plasticize the plastic pipe 1. The plastic of the reinforcing band 5 is also plasticized by the hot air that is produced, causing the reinforcing band 1 [sic] to become welded to the plastic pipe 1 as the subsequent pressing rollers 40, 41 press the reinforcing band 5 against the plastic pipe 1.

Figure 6 provides a more detailed view of a cutting device 42 of arrangement 14, which includes a cutter 43. When the reinforcing band 5 has been wound around the plastic pipe 1 to the desired length, the cutter 43 is traversed to the left through a cylinder to sever the reinforcing band 5. Reinforcing band 5 is held in place during this process by a metal counter-sheet 44. The end area of the severed end of reinforcing band 5 is then welded to the immediately underlying area of the reinforcing band by means of the hot air blower and pressing rollers 40, 41.

Figure 8 illustrates another embodiment of an arrangement 14 for applying a reinforcing band 5. In this embodiment, plasticized plastic is extruded directly onto the plastic pipe 1, the reinforcing material being fed in separately. Wound onto a drum 46 is a plastic wire 48, which is fed into a small-screw extruder 45. Disposed in the small-screw extruder 45 are an extruder screw and a heater, which plasticize the plastic that is fed in. The plasticized plastic is fed via connecting neck 49 into a crosshead 50 having a cylindrical cavity that tapers to the nozzle 51. Also wound onto a drum 53 is reinforcing material 47, particularly natural fibers, synthetic fibers, synthetic yarns, glass fibers, fiberglass fibers, Kevlar fibers, carbon fibers, metal fibers or metal wires and yarns or woven fabrics made of these reinforcing materials. The reinforcing material is conveyed by a pushing device 54 into a conical cavity in crosshead 50 and exits through a separate channel of nozzle 51, whereupon it is enveloped by the plasticized plastic. This yields a reinforcing band, which is applied by pressing roller 52 to plastic pipe 1. The hot air device need only locally plasticize the plastic pipe 1, since the plastic of the reinforcing band is already in the plasticized state. Shortly before the end of the wrapping or extruding-on process, the reinforcing material is severed by a cutting device 55 to terminate the winding-on of the reinforcing band 5.

The nozzle 51 of crosshead 50 can be configured as a round nozzle or a flat nozzle. A round nozzle is preferably used with reinforcing material that has a round cross section. For a flat woven metal or synthetic fabric, on the other hand, a corresponding flat nozzle is preferably used.

Figure 9 illustrates a modification with respect to the arrangement shown in Fig. 8. In this exemplary embodiment the reinforcing material is fed in, not through the crosshead, but from the outside instead. Thus, the reinforcing material is first brought into contact with the plastic pipe 1 by means of a guide (not shown), and is then covered with plasticized plastic, which in this exemplary embodiment emerges from a wide-slit nozzle 54. The cutting device 55 and the pushing device 56 are not disposed behind the crosshead in this exemplary embodiment, but rather to the side of it.

Alternatively to the exemplary embodiments depicted in Figs. 8 and 9, the feeding-in of reinforcing material can also take place such that short-fiber reinforcing materials are fed into the small-screw extruder 45 along with the plastic. The drum 53 for the reinforcing material, corresponding guides for the reinforcing material and a cutting device can be dispensed with in this exemplary embodiment.

Still another exemplary embodiment of an arrangement 14 is illustrated in Figs. 11 and 12. In contrast to the exemplary embodiment depicted in Fig. 7, here the reinforcing band and the plastic pipe 1 are plasticized with a laser 58 and are then joined together by means of pressing rollers 40, 41. The particular advantage of using a laser is that the plastic to be plasticized can be warmed in a very contained manner, so that the overall thermal action is less than that which obtains with a hot air apparatus. As illustrated in Fig. 12, by beam focusing, the laser can also be used to cut the reinforcing band 5, thereby reducing the number of contrivances needed. Alternatively, however, a mechanical cutting device can also be provided.

In all of the above-described exemplary embodiments, it is advantageous if the reinforcing band or reinforcing material is applied to the plastic pipe with a prestress. A tensile stress of more than 100 N to 1000 N – depending on the diameter of the plastic pipe and the degree of reinforcement – can thus be applied to the reinforcing band or reinforcing material during the wrapping process. This can be accomplished by having the arrangement that effects the rotating unwind the reinforcing band or reinforcing material under tensile stress, either the corresponding drum or the reinforcing band or material being braked under its own control by means of a holdback mechanism.

In the above-described exemplary embodiments, it is also conceivable to weld reinforcing band 5 to plastic pipe 1 only in preset lengths. This further reduces the energy consumption and associated thermal loading, with virtually no adverse effect on the reinforcement of the plastic pipe 1 against permanent static loads.

In the above-described exemplary embodiments it is advantageous to provide computer control to drive the individual motors, the cutting device, the heaters or lasers and the other arrangements, to permit fully automatic operation.